# Investigating demographics and Acanthocephalan parasite load of *Emerita analoga*: A model to engage urban youth

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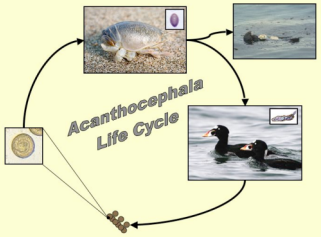
ABSTRACT: The Sand Crab Monitoring Project is a National Marine Sanctuary program with two main goals: to engage youth in the protection of California's coastal resources through participation in intertidal monitoring and to generate a long-term, quantitative dataset for use in assessing changes in the health of sandy intertidal ecosystems along the west coast of the United States. Here, we focus on data collected by trained high school and college interns from the Careers in Science Intern Program at the California Academy of Sciences. The interns, who hail from groups typically underrepresented in the sciences, have monitored the abundance, distribution, and Acanthocephalan parasite load of *Emerita analoga* at Ocean Beach in San Francisco since 2003. *E. analoga* often dominate the biomass of sandy beach communities and are the primary intermediate hosts for Acanthocephalanes. Definitive and dead end Acanthocephalane hosts, such as Surf Scoters (*Melanitta perspicillata*) and sea otters (*Enhydra lutris*), are infected when intermediate hosts are ingested. Mean *E. analoga* abundance declined considerably across years. In both 2004 and 2005, the rate of Acanthocephalan infection in the *E. analoga* population was 55%. However, from 2003-2005, the mean number of parasites per infected crab increased significantly from 1.00 in 2003, to 1.98 in 2004, to 2.75 in 2005. This increase could result in a proliferation of parasites in definitive and dead ends hosts. The value of this project extends far beyond the creation of a long-term dataset. Student participants become excited about the world's oceans, experientially learn the need for environmental stewardship, and often pursue careers in the sciences. Of the former Careers in Science interns that have participated in the Sand Crab Monitoring Project, 68% have pursued marine science related research opportunities in college. We hope this study will serve as a model for future monitoring projects throughout the world.

## INTRODUCTION

The mortality of Surf Scoters (*M. perspicillata*) and the federally endangered southern sea otter (*E. lutris*) is linked to infection by acanthocephalan worms (Hennessy and Moorejohn, 1977; Mayer et al, 2003). Pacific mole crabs, *E. analoga*, are the primary intermediate host for Acanthocephalans. Student interns from the California Academy of Sciences (CAS) have been investigating the Acanthocephalan parasites of *E. analoga* on Ocean Beach, San Francisco, CA since 2003. The two main objectives of this collaborative project, a sub-set of the National Marine Sanctuary's coast-wide student monitoring program LiMPETS (Long-Term Monitoring and Experiential Training for Students) are:




1) To engage youth in the protection of California's coastal resources through participation in the student monitoring program, LiMPETS.
2) To examine demographics and annual variability of mean parasite density in Pacific mole crabs.

## METHODS

CAS interns monitored the population of *E. analoga* at a permanent survey area on Ocean Beach, San Francisco, CA once per week, June through August, from 2003-2006. The survey area was 50 m x 10 m in size.

- Samples were collected with cores along 3 randomly spaced transects across the swash zone.
- Length and sex of all live specimens was determined.
- From 2004-2006, 10 adult crabs (length > 9 mm) were randomly selected during each sampling and were subsequently frozen for parasite analysis.
- On the public floor of the museum, *E. analoga* were measured, sexed, and dissected by removing the carapace and examining the homecoel for parasites. Prevalence, intensity of infection, and mean abundance of parasites was calculated.

## MONITORING RESULTS

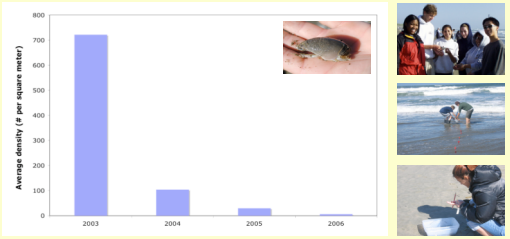





***Figure 1:** Mean density of E. analoga population during summer months, 2003-2006. In 2003, there was a large recruitment event that yielded an unusually high number of recruits on Ocean Beach.*

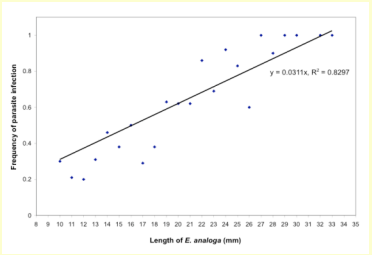



***Figure 2 :** The relationship between mole crab length and frequency of crabs infected, 2004-2006 (N=143, r=0.8297, p < .001).*

- ***A highly significant positive relationship exists between crab length and frequency of infection.***
- ***There is a marked sexual dimorphism in size in this species. Males reach lengths of up to 22 mm and females up to 35 mm. Therefore, females are more frequently infected by parasites.***
- ***100% of the largest females in the population (>28 mm) were infected with parasites.***

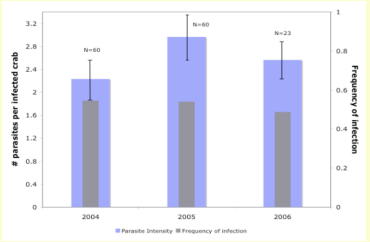



***Figure 3:** Frequency and mean intensity (±SE) of parasite infection in the E. analoga population during summer months at Ocean Beach, CA.*

- ***Annually, approximately 50% of the summer population of adult mole crabs were infected with Acanthocephalan parasites. Frequency of infection remained constant across years.***
- ***The mean number of parasites per infected mole crab varied across years. Infected mole crabs on Ocean Beach carried an average of 2-3 parasites within the homecoel.***

## PROGRAM IMPACT

68% of interns who participated in the monitoring program are interested in OR are actively pursuing a career in science!

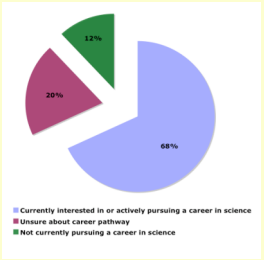



***Figure 4:** Career pathways of interns in the monitoring program.*

| Intern | Years of Participation | Age | School |
|---|---|---|---|
| Chris F | 2 | 16 | College Prep High School |
| Samson G | 1 | 16 | Gateway High School |
| Tarah R | 1 | 16 | Galileo High School |
| Ben H | 3 | 17 | Lowell High School |
| Jenny H | 1 | 17 | Lowell High School |
| Johnson Y | 3 | 17 | San Francisco State University |
| Pierre M-B | 1 | 17 | SR Martin Prep |
| Rubi S | 2 | 17 | Lowell High School |
| Waziri A | 2 | 17 | SR Martin Prep |
| Alex D | 3 | 18 | City College of San Francisco |
| Alex T | 3 | 18 | CSU-Monterey Bay |
| John W | 2 | 18 | High School in Texas |
| Lily Z | 3 | 18 | Skyline Community College |
| Denise C | 4 | 19 | University of California, Davis |
| Dylan M | 3 | 19 | Bowdoin College |
| Francisca H | 4 | 19 | City College of San Francisco |
| Luciano G | 3 | 19 | City College of San Francisco |
| Jessie Y | 4 | 19 | University of California, Davis |
| Krystle D | 4 | 20 | Vista Community College |
| Monica V | 4 | 20 | San Francisco State University |
| Sam C | 4 | 20 | University of California, Santa Cruz |
| Maya W | 4 | 21 | Oberlin College |
| Brandon K-L | 2 | 22 | University of California, Davis |
| Dominic M | 2 | 23 | University of California, Davis |
| Francisco A | 2 | 23 | City College of San Francisco |

***Figure 5:** The budding scientists that have participated in the monitoring project from the California Academy of Sciences since 2003.*

## CONCLUSIONS

- Long-term participation in the LiMPETS sand crab monitoring project by trained interns at the California Academy of Sciences has yielded a reliable and valuable four year dataset. Student monitoring programs, such as LiMPETS, can successfully contribute to scientific endeavors that monitor the health of our ocean environments.
- *E. analoga* abundance has declined drastically over four years, and approximately 50% of the adult *E. analoga* on Ocean Beach are infected with parasites.
- Long-term participation in scientific monitoring programs can connect youth to the oceans, directly engages them in real science, and can strongly motivate them to pursue a career in environmental science.

## REFERENCES:

Mayer, K.A., Dailey, M.D., and M.A. Miller, 2003 Helminth parasites of the southern sea otter *Enhydra lutris nereis* in central California: abundance, distribution and pathology. *Diseases of Aquatic Organisms* **53**, 77-88.

Hennessey, S.L. and V.J. Morejohn, 1977 Acanthocephalan parasites of the sea otter, *Enhydra lutris*, off coastal California. *California Fish and Game* **63**, 268-272.

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